FIELD GUIDEBOOK

to

ENVIRONMENTS OF COAL FORMATION IN SOUTHERN FLORIDA

Trip Leaders

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useful index to the environmental site - shoreline relationships when the conditions are comparable to the area herein described. Also of interest is the concentration of Avicennia pollen in the various samples. The pollen of this plant is most commonly represented in the marine to brackish zone just behind the coast and disappears from the sediment before the headwaters are reached. Therefore, the pollen concentration in the sediment accurately reflects the greater areal distribution of Rhizophra and the comparatively restricted range of Avicennia. All of the sources of the Chenopodiaceous pollen have not as yet been ascertained, hence the relationship of these pollen concentrations to the source plants cannot be stated. It seems apparent, however, that a large concentration of Chenopodiaceous pollen associated with a very small representation of Rhizophora pollen reflects the brackish to fresh-water transition zone in this area (salinity of 200 ppm NaCl). A more or less equal representation of these two pollen types plus a reasonable amount of Avicennia pollen is an index of brackish environment (salinity of ca. 4000 ppm) and a large concentration of Rhizophora pollen, with little or none of the other two represented, is a reflection of the type of marine conditions prevalent along the coastline (salinity of 36,000 ppm).

STOP 21: Buried Peat Site

Objectives:

A. Procurement and inspection of cores of the sediment sequence one-half mile off the western coast of Florida.

B. Discussion of the age of the sediment, elemental concentrations and pollen content in onshore and offshore cores taken in an E-W transect.

C. Discussion of the evidence for marine transgression provided by the core data.

D. Summary of the distribution of phytogenic sediments in southwestern Florida.

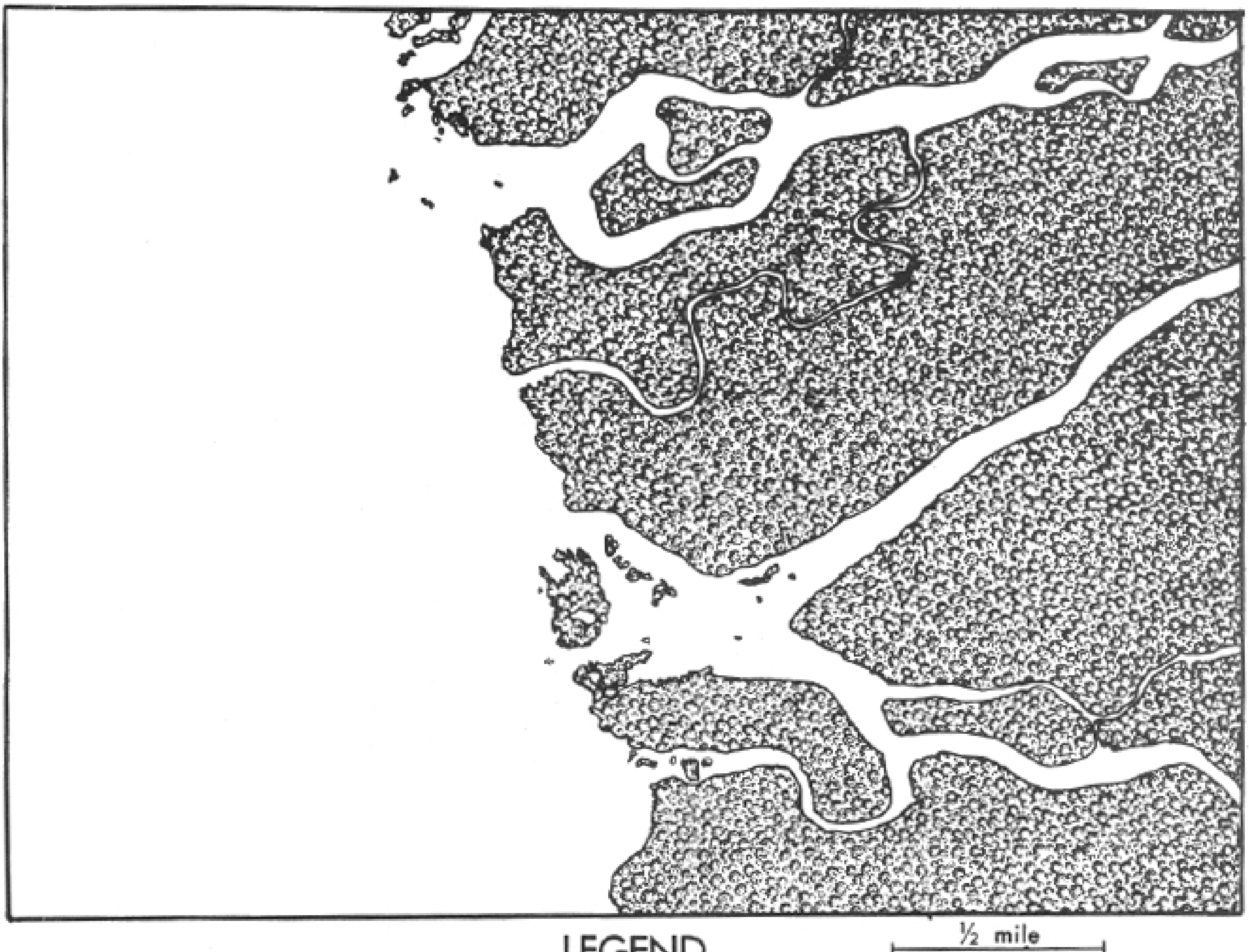
Discussion:

Davis (1940) pointed out that the thickness of the peat near the mouth of the Shark River was far greater than the tidal range and he inferred this to be evidence of a relative rise in sea level. The mean tide range at the Shark River mouth is 3.6 feet (U.S.C.G.S. 1962), with spring tides sometimes reaching 4.5 feet. Davis mentioned peat thickness "greater than 10 feet" and the present investigation has shown sediment thicknesses greater than 15 feet in this area. Since there is no evidence to indicate a greater tidal range in the past, and in view of the fact that the present peat surface is awash at high tide, Davis' inference appears valid. Or, perhaps, it is more accurate to say that either a sea level rise or a local subsidence is indicated.

When extensive coastal swamps form the shoreline as they do in southwestern Florida, it is possible for the accumulation of peat to keep pace with either a rising sea level or a local subsidence. It is also possible for the aggradation of organic material to either lag behind or exceed the rate of sea level rise. Thus, one can conceive either a still-stand of the coastline or a regression or transgression of the sea, depending on the differential rates involved. Davis implied that historical accounts of red mangrove inland from their present limits suggested that the mangrove forest was moving seaward (Davis, 1940). The evidence encountered in the course of more recent studies makes it quite evident that the southwestern Florida coast has been under the influence of a transgressing sea for the last 4000 - 5000 years.

The most convincing evidence of the transgressing sea was encountered while coring near the mouth of the Harney River, some two miles north of the mouth of the Shark River (see Figure 53 and Plate XXII). About one-fourth of a mile from shore a layer of peat was encountered beneath three feet of lime mud. The peat layer proved to be 6 to 7 feet thick and additional exploration showed it to be continuous with the 13'6" of peaty sediment present on shore beneath the mangrove forest. Seaward the peat extends out at least a mile and three-quarters in this area, at which point only one foot of peat is present and this is covered by 6'6" - 7' of marly sediment. The basal peat a mile and one-half off-shore has been dated at 4420 ± 200 years and the basal peat (13'3" - 13'5") at the onshore site was dated at 4080 ± 180 years.*

* Radiocarbon dates courtesy of Shell Development Company.



LEGEND

BLACK MANGROVE

OPEN WATER

MAP OF ENVIRONMENTS IN THE HARNEY RIVER AREA

Figure 53

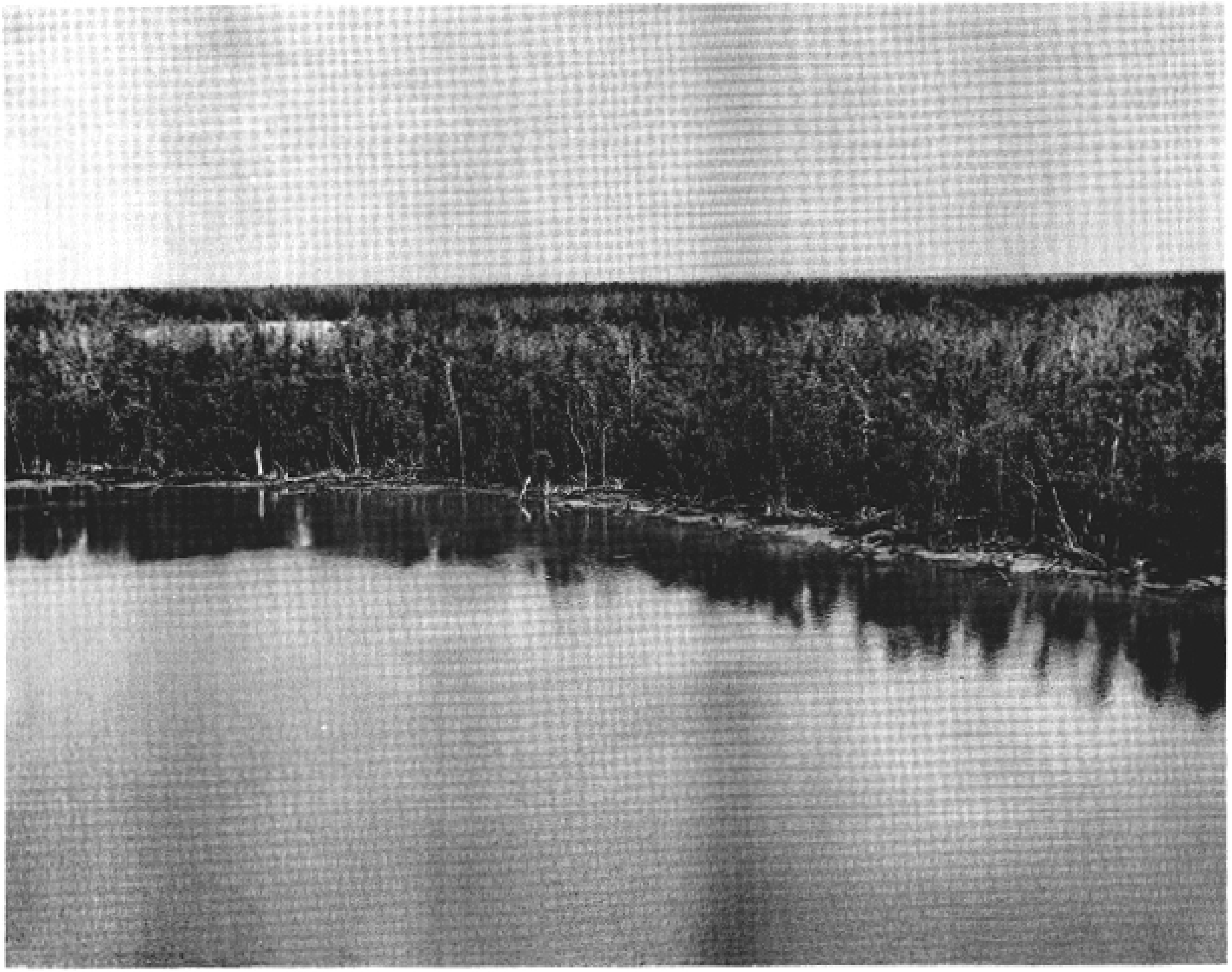


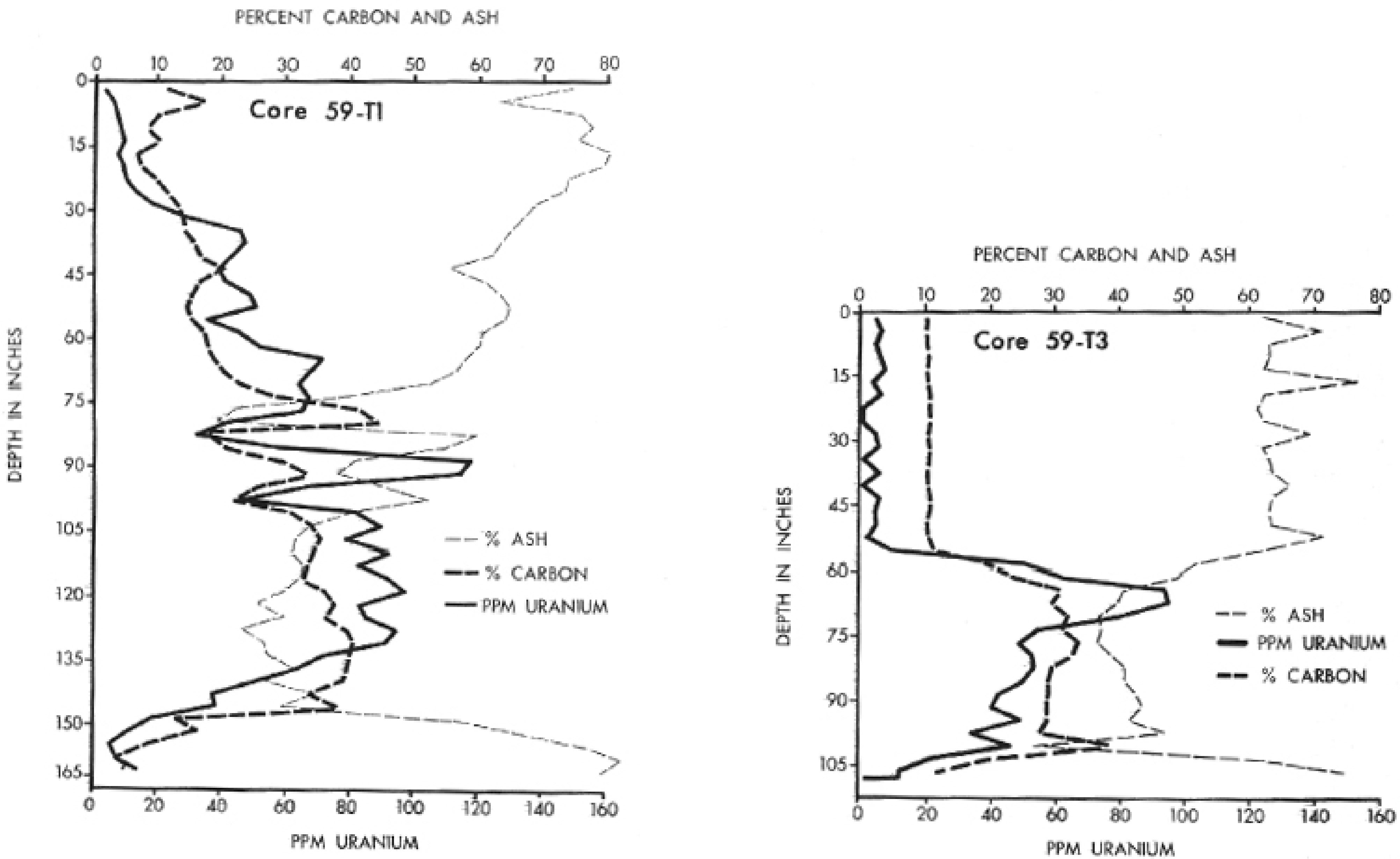
PLATE XXII

A marked change in the character of the core taken at the onshore site (Site T1) occurs several feet above the flat Miami oolite surface on which the peat was deposited. At this level the sediment changes to a limey peat and then to a peaty lime mud. This is well illustrated by the graph presented as Figure 54 which shows the relative concentrations of ash, carbon and uranium in the sediment. In the upper zone foraminifera were common in the sediment but they were not noted below the 7 foot level. The same general relationships hold three-quarters of a mile offshore as shown by Figure 54. Note the positive correlation of the concentration of uranium with the concentration of carbon and the negative correlation with ash.

On the basis of these data, the reconstruction presented as Figure 55 appears justified. There seems little doubt that the sea has been transgressing over the land in this area, as evidenced by the autochthonous peat layer that extends out more than a mile and a half as a continuation of the sediment mass now found under the coastal mangrove forest.

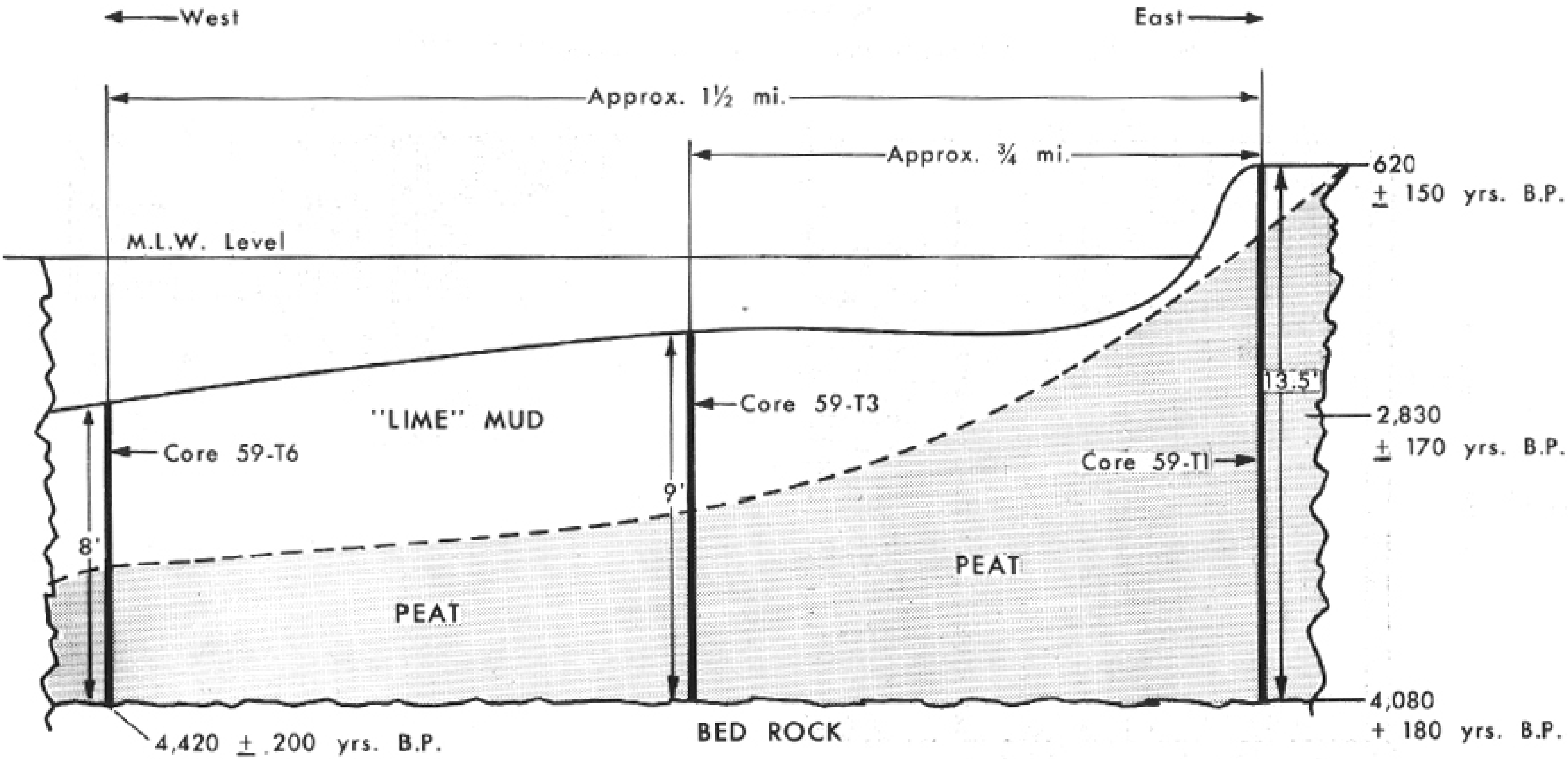
A second convincing evidence of transgression is to be found in the character of the peat in the onshore core (Site T1). Inspection of the data presented in the pollen profiles (Figure 56) will show the manner in which the concentrations of certain pollens in the sediment have changed during the past 4000 years. The basal two feet of sediment in the deeper core are quite different in pollen content from the overlying sediments. They contain only very small quantities of Rhizophora pollen, even less Avicennia pollen, and sizeable quantities of pollen from fresh-water species, particularly from sedges, fresh-water aquatics and pine. Such a pollen assemblage was encountered some 14 to 15 miles inland where the salinity is less than 200 ppm. Hence, this basal peat layer appears to be a fresh-water or mildly brackish sediment whose geographic position is now coincident with the shoreline and hence overlain by a marine environment. Such a condition could come about only with a transgression of the Gulf over the southwestern Florida coast.

If the above is true and if the transgression has been more or less continuous, one would expect to find a series of progressively more marine strata lying on the basal peat. Further inspection of the pollen profile



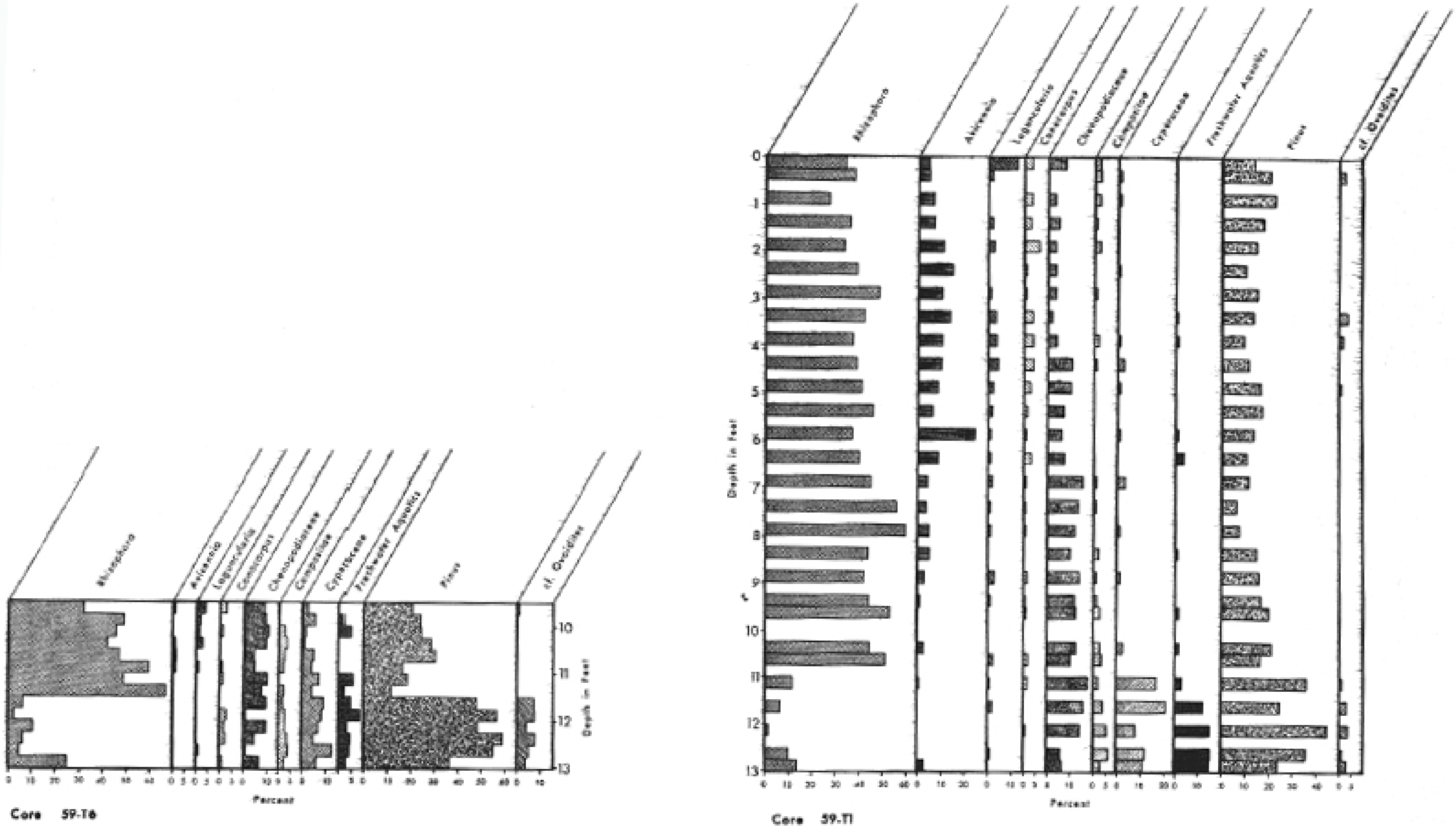
VARIATION IN CARBON AND URANIUM CONTENT AT SITE 59-T1 AND SITE 59-T3

Figure 54



GENERALIZED CROSS SECTION SHOWING SEAWARD EXTENSION OF PEAT

Figure 55

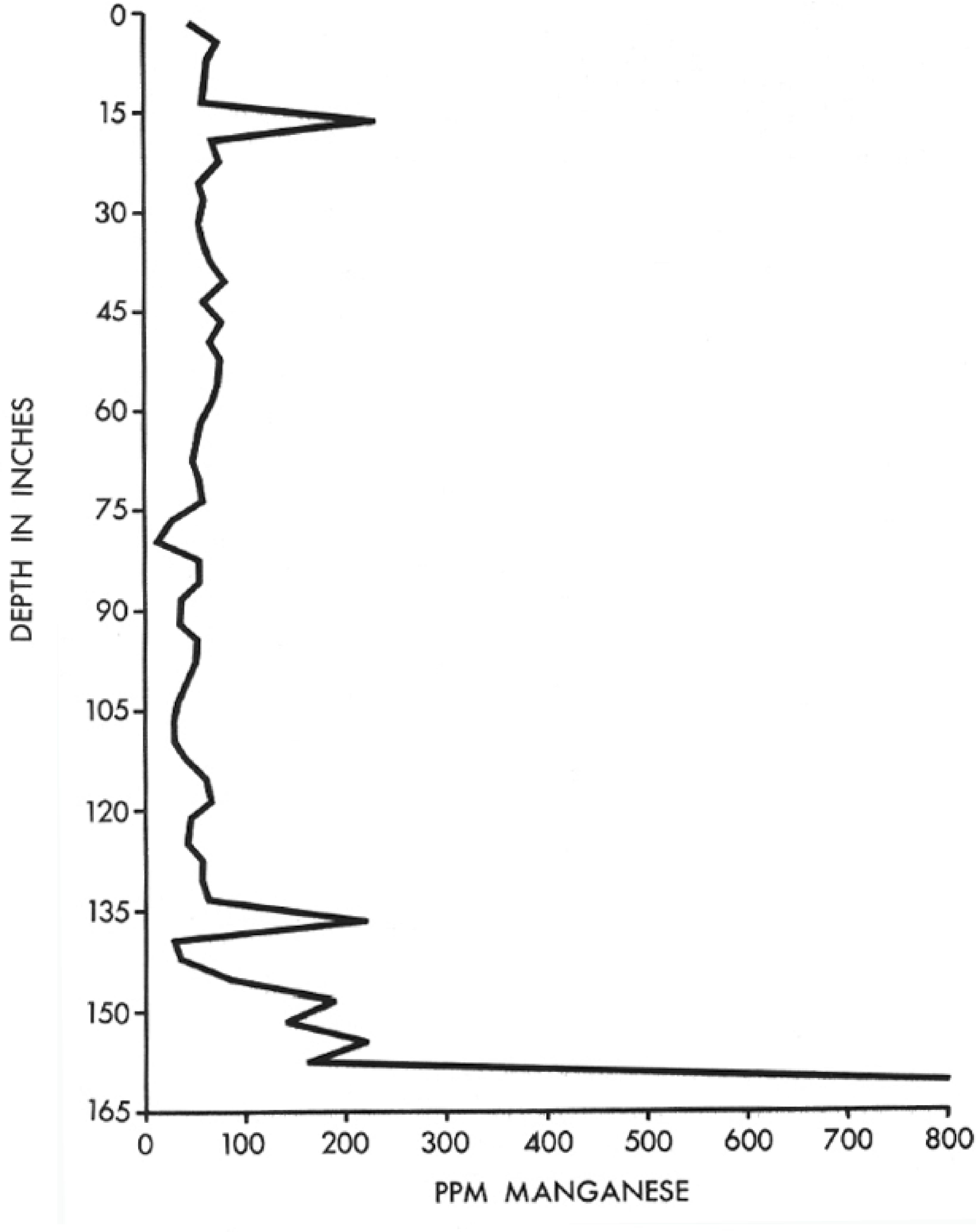


POLLEN AND SPORE CONCENTRATIONS AT VARIOUS LEVELS IN CORES FROM SITES T-6 AND T-1

Figure 56

will reveal that there is an abrupt increase in the concentrations of Rhizophora pollen near the 11 foot zone, suggesting a rapid change in conditions or a disconformity at that level in the peat. Avicennia reaches its maximum concentration in a zone that lies between one and six feet below the present surface. In the upper one foot of the sediment, Avicennia is reduced in concentration and the Chenopodiaceous pollen reaches its maximum abundance in the center section of the core. These facts suggest that this core contains, in its 13 feet, representatives of three major environmental zones: the fresh-water zone, the brackish zone and the coastal marine zone. Thus, the equivalent of some 15 miles of swamp is recorded in the vertical sequence. Whether the coast was ever 15 miles offshore during the last 5000 years is another question, as it is obviously not necessary that 15 miles be involved in the marine to fresh-water transition. In the case in question, however, considerable evidence could be brought to bear to show that the broad expanse of the Shark River channel system has been a main drainage way for water flowing southward from Lake Okeechobee for a considerable period of time. This, plus the essentially horizontal attitude of the Floridian Plateau surface in the offshore area, suggests that the salt to fresh-water transition has not been very abrupt in the recent past along what is now the course of the Shark River. It seems likely that at least several miles of shoreline regression have occurred during the last 5000 years.

Confirming the conclusions derived from the pollen data are data derived through the studies of trace elements in the sediments. The best example of this is to be found in the distribution of manganese in the onshore core (Site T1). Figure 57 is a graphic profile showing the relative concentration of manganese at various levels in the thirteen and one-half feet of sediment. As is evident from the figure, the basal two feet contain quantities of this element that tend to set this section of the core apart from the overlying strata. Reference to Figure 51 will show that concentrations of manganese comparable to those in this basal layer were characteristic of certain brackish to fresh-water sites that lie between 10 and 18 miles from the present shoreline. Hence, two quite different analytical techniques provide data that point to the



MANGANESE CONCENTRATION IN CORE FROM SITE T

Figure 57

same conclusion.

It appears probable that the transgression has proceeded at different rates at various points in time. For example, during the interval represented by the basal six feet of peat, the rise in sea level must have only slightly exceeded the rate of accumulation of organic material, thus yielding a peat with comparatively small amounts of mineral matter, while permitting a gradual transgression of the saline environment over the fresh water site represented by the basal one or two feet. About 3000 years ago the rate of accumulation of organic material fell below the rate at which mineral matter was brought into the area of tidal overflow. This may imply a more rapid rate of transgression and relative sea level rise. Were this not true, the accumulating peat would minimize the impact of tidal overflow and hold the concentration of mineral matter at a low level. In the very recent past another increase in the rate of sea level rise must have occurred, for the surface sediment at the onshore site was dated as being 500-600 years old. This, of course, suggests that accumulation of sediment may have ceased and that the surface is undergoing erosion at the present time. Abundant evidence of a recent reduction of the general level of much of the tidal area has been shown at inland sites where clumps of saw grass and other vegetation stand on steep sided pillars of peat with the surface 12-18 inches above the present high water level (see Figure 47).

A series of other features of the area attributable in some measure to the influence of the transgressing sea have been observed. Some that have been described might be attributed to normal storm action along the coast and it would be difficult to prove that this was not the case. The reason for reiterating these features at this point, is that one should expect them as commonplace effects where a low plain coast is subjected to marine transgression. Were they to fail to occur here, it might cast some doubt on the validity of the conclusions thus far drawn.

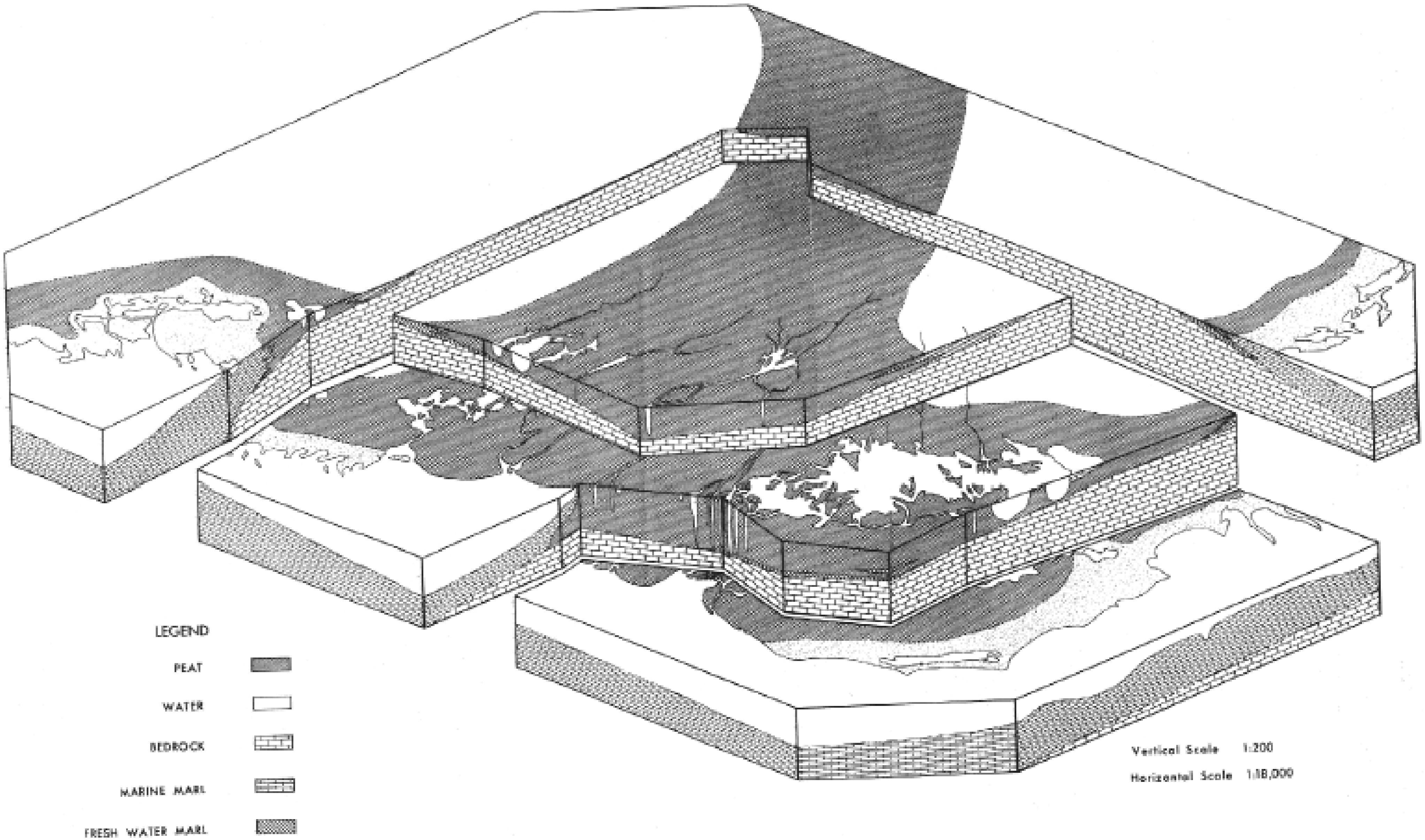
One of the most obvious evidences of the sea's transgression is to be seen at the coast. Although the red mangrove trees have often been referred to as a pioneer species which build up new land by catching and retaining debris in their maze of prop roots, the great number of fallen and dead trees along this coast make it evident that the mangroves are here losing ground to the sea (Plate XXII). The coastal chart of the area shows islands and points which exist presently only as shallows or mud banks, often covered by the sea even at low tide. An anchor dropped in the middle of Ponce de Leon Bay will take hold in solid peat.

In some places drowned forests extend out beyond the shoreline in the form of stumps that are still rooted in their original site. In areas receiving the full impact of prevailing winds and currents, extensive storm beaches have partially buried and killed the marginal forest. To some extent this is to be expected along any exposed coast of this type but the effect appears to be intensified in this area.

The coastline in certain sectors is being dissected into an array of isolated but clearly related islands and the islands themselves are undergoing dissection through intense tidal scour. Every stage in the dissection of an island can be observed in the area. The steepness of the inter-island channel walls in the Ponce de Leon Bay area is evidence that the peat forming the islands and standing like a pillar beneath the forest, is in an environment quite dissimilar from the one in which the sediment accumulated. The channels are carved down to the Miami oolite surface and are 12-15 feet deep, often with almost vertical walls.

After some study of the area, one develops the impression that the intensive tidal scour initially produces extensive tidal flats where the mangrove forest once stood. These are well developed in the area south of Little Shark River where the outflow of fresh-water does not buffer the effects of the tidal overflow. After tidal flat development, channel deepening and island formation begins as the area undergoes its dissection. In some sectors, such as those in the vicinity of the Lostman's and Rodgers Rivers, inland bays begin to form, ultimately converting a former land surface into a vast inland lagoon as the result of removing the peat that formed the land to begin with. Hence, it seems likely that a gradual rise in sea level was initially responsible for the creation of much of the land surface in this area and the continued rise at an accelerated rate is now causing the destruction of the coastal area.

A block diagram of southwestern Florida showing the extent of the blanket of phytogenic sediments is presented as Figure 58. From the preceding discussion it is evident that these sediments are the products of a number of different swamp and marsh environments. The boundaries between these environments is often well-defined and the vegetation occupying the sites is often relatively simple in composition. This renders the area suitable for initial studies of the complex processes involved with peat formation. Study of the area is also informative in connection with gaining some insight into the impact of a transgressing sea on peat-forming environments.



BLOCK DIAGRAM OF SOUTHWESTERN FLORIDA
Figure 58